

DESCRIPTIONS OF NEW SPECIES OF CORALS FROM
THE AUSTRALIAN TERTIARIES.

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PART I.

WITH PLATES II., III.

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It will, I think, be ultimately found that the Australian Tertiaries are specially rich in corals. So far nearly 60 species have been described, almost solely by Professor M. Duncan and the Rev. J. T. Woods, but the unnamed ones in collectors' hands are still numerous.

In addition to my own gatherings, the material available includes contributions from Professor Tate and Mr. J. Mulder, who have generously allowed me to select what I chose from their cabinets.

A revision of the forms described by previous authors is also desirable, and will be undertaken when further examples of the various genera represented have been discussed.

In the present paper I deal with seven species, which are included under five genera and two families.

FAMILY TURBINOLIDÆ.

GENUS FLABELLUM.

Flabellum Gippslandicum, *spec. nov.* Pl. ii., figs. 1 a, b.

The corallum is compact in substance, of varying height, sometimes tall in relation to its breadth, straight, much compressed, and wedge-shaped. The sides are rounded and slightly inclined to the base, the angle subtended being about 10°. The anterior and posterior surfaces are flattened, and also inclined to each other at a similar angle. The base is crescent-shaped and much eroded; not unusually the horns of the crescent are slightly prolonged outward.

The calice is shallow and elliptical, with the plane of the shorter axis somewhat higher than that of the longer; the two axes of the ellipse are as 100 to 44. There are five cycles of septa with six systems, of which only the two central ones are complete; in the figured calice the septa number 76. The first three orders are stout and equal; the higher orders diminish both

in length and thickness, the fifth being very short and thin. All the orders are wavy, and, with the exception of the highest, show several radiating rows of granules on their sides.

The fossa is long, narrow, and abruptly descending. Most specimens have the wall of the corallum broken off level with the columella, which is formed by the fused ends of the principal septa; but in more perfect examples the columella is either not visible or can be just seen deep down in the fossa.

The costæ are subequal in size, closely-set, and correspond to the septa. As a rule, they are almost concealed by the epitheca, but when this has been worn off by fossilization they are distinct on the sides of the corallum. In well-preserved examples the epitheca is dense, and shows chevron-marked ridges running parallel with the convex calicular margin.

Height of corallum (figured example), 31 mm.; length of calice, 16 mm.; breadth of calice, 7 mm.

Locality.—Abundant in the Miocene beds of the Gippsland Lakes area, Victoria.

This coral is allied to *F. Victoriae*, Duncan, but is more compressed and much larger. It has besides an extra cycle of septa.

Flabellum fastigatum, *spec. nov.* Pl. ii., figs. 2 a, b.

The corallum is elliptico-conical in shape, and tapers regularly from the summit to a very small pedicel at the base. The angle subtended by the lateral borders of the corallum is about 30°, and that by the middle line of the faces about 18°. The calice is elliptical and deeply excavated. The two axes of the ellipse are as 100 to 56.

The septa are slender and straight; they have dentated edges, and their sides are ornamented with rows of small rounded granules. They are in six systems, with four cycles. The two central systems only are complete, those at the ends wanting either a secondary or tertiary, and also one or more of the quaternary septa. The primaries, secondaries, and tertiaries are well developed and equal; the quaternaries are nearly as long, but thinner and less prominent from the wall. The inner borders of the principal septa are perpendicular, and enclose a narrow, deep, and elongate fossa, at the bottom of which is the columella; this is formed by the thickened and fused ends of the septa of all four orders. Only one of my examples shows a deep central fossula in the calice, the others, as is frequently the case with fossil *Flabella*, having the corallum broken off or worn to the level of the columella. The wall is thin towards the calicular margin, but becomes stout inferiorly.

The principal costæ are prominent on the surface of the corallum as medially furrowed and slightly raised ridges, which

correspond to the three first orders of septa. There are no costæ of the fourth order. The ridges which constitute the lateral costæ are larger than the others, and can be traced almost to the terminal pedicel; two or three of those on the middle of the faces reach as far, but the remainder are successively cut off by the lateral slope of the cone. All become less conspicuous as they approach the base.

The epitheca is strong and continuous on the surface of the corallum; it forms a transverse ornament of wavy lines both on the costæ and their interspaces.

Height, 30 mm.; length of calice, 18 mm.; breadth of calice, 10 mm.

Locality.—Rare in the Eocene cliffs at Spring Creek, 13 miles south of Geelong, Victoria.

Flabellum curtum, *spec. nov.* Pl. iii., fig. 3 a, b.

The corallum is compressed, especially inferiorly, and in outline almost an equilateral triangle, of which the upper margin represents the base, and the short swollen pedicel the apex; its lateral borders are gently rounded. The calice is shallow and elliptical, the ratio of the axes of the ellipse being as 100 to 52; the plane of the shorter axis is considerably higher than that of the longer, and the summits of the faces are consequently much arched.

The septa are granulated, slightly curved, and faintly waved on their upper margins. They are in six systems, with five cycles, four only of which are developed in the end systems. Each of the latter contains two principal septa, viz., the primary and either the secondary or one of the tertiaries; the higher orders are present, but correspondingly few in number. The half calice figured shows only two quinarys in the end systems instead of four, none being developed on either side of the quaternaries which flank the middle system. In other calices examined the quinarys are present in these spaces, but are wanting on the sides of the adjoining quaternaries at the extremities of the middle system. For the three systems figured there are 28 septa, or 56 for the entire calice. The primaries, secondaries, and tertiaries are stout and equal, and bound a moderately broad and deep axial fossa; the quaternaries are nearly as long, but much thinner, while the quinarys are still smaller and very short. The inner margins of the principal septa are vertical in the fossa and strongly wrinkled; they are free for a considerable distance down, and then unite by stoutish, twisted processes to form a rudimentary columella.

The costæ are marked on the surface by broad rugose bands with narrow interspaces, and radiate from the pedicel to the arched margin. They are of equal width for their inferior two-

thirds, when the more central ones divide into pairs up to the margin, the division line between each pair being faint. The costæ visible superiorly correspond to the septa. The epitheca is rough, dense, and persistent; it forms broad convex bands here and there on the surface, running parallel with the calicular margin, and most distinct in the interspaces of the costæ.

Height, including pedicel, 11 mm.; length of calice, 10·5 mm.; breadth of calice, 5·5 mm. All the examples found are practically uniform in size.

Locality.—Tolerably numerous in the Miocene beds of the Gippsland Lakes area.

GENUS PLACOTROCHUS.

Placotrochus corniculatus, *spec. nov.* Pl. ii., figs. 3 a, b.

The corallum is horn-shaped, smooth, and finely pedicellate. In young specimens there is a slight constriction just above the pedicel. The wall is thin at the summit, but becomes stouter inferiorly. The epitheca is strong, and is marked by transverse wavy ridges and lines, which are most numerous in the upper half of the coral, and reach the calicular margin. The calice is shallow and elliptical, but the relative lengths of the major and minor axes of the ellipse are not constant in the species. Thus in three examples measured the axes are respectively as 100 to 64, 100 to 72, and 100 to 82.

The septa are slightly exsert and most symmetrically disposed. They are in six systems, with four complete cycles; the primaries and secondaries are moderately stout and equal, the remaining orders becoming successively smaller. Though straight as regards their main direction, the septa are strongly waved and wrinkled, especially the primaries and secondaries for the inner two-thirds of their course. Perpendicular rows of moderate-sized, pointed granules are alternately placed on either side of the septa of the first and second orders, the summit of each successive fold carrying, as a rule, a single row of granules. Occasional granules also occur on the septa of higher order.

The columella is a straight, thin, and short lamella with rounded margins, and projects distinctly from the bottom of the fossa.

The costæ correspond to the septa. The primary lateral costa on the convex curve of the corallum forms a strong well-marked ridge, which in some specimens is nodose. Other prominent ridges mark the secondary and the remaining five primary costæ. In the spaces between the ridges, which are barely concave, the tertiaries and quaternaries are indicated by faint lines.

Height, 20 mm.; longer axis of calice (type), 9 mm.; shorter axis, 6·5 mm.

Locality.—Eocene clays of the Adelaide bore, South Australia. Collected by Professor Tate.

GENUS PARACYATHUS.

Paracyathus Tasmanicus, *spec. nov.* Pl. ii., figs. 4 a, b.

The corallum is almost, occasionally quite, straight, and cylindro-conical in shape, with an expanded calice and a very broad flat base, which affords evidence of having been attached to a foreign substance. The calice is elliptical and concave, with a deep central fossa. The relative lengths of the major and minor axes of the ellipse are as 100 to 86.

The costæ are continuous with the septa, and more conspicuous in the superior than in the inferior portion of the corallum. The epitheca is pellicular and thin.

The septa have rounded upper margins, and are thickest at the wall, above which they rise to varying heights, according to cyclical order. They are in six systems, with four cycles. In the example figured the quaternaries are wanting for half of one system; another example shows the systems all complete. The primaries and secondaries are sub-equal in size, and the higher orders become successively both smaller and shorter. All the septa have numerous pointed granules on their sides. There are distinct pali before all the orders except the last, the youngest reaching higher in the calice than the secondaries, and these again than the primaries. Several smaller pali towards the base of the fossa are hardly distinguishable from the papilli of the columella. Both the pali and the columella are well preserved in the figured calice, which belongs to an aged example, but the septa are worn and largely connected by growth rings. In fact, the outer portion of the septal area is much filled up by calcareous matter, to which Lindström has applied the term *stereoplasma*. That the presence of this in such a position in the calice is not of classificatory importance is insisted upon by Duncan,* and its occurrence in the fossil coral here described fully supports his views. Two other examples (one of which is the corallum figured) have the septa perfect, and the calices entirely free from any such growth; but as in both cases the pali were partly broken down in clearing the fossa from sediment, their calices would not serve so well for illustrating the characteristic features of the species. Other poorly preserved specimens are also to hand, several of which are free from *stereoplasma*, while one or two of them show its presence to some extent.

* Revision of the Families and Genera of the Madreporaria. Journal Linn. Soc., Zoology, vol. XVIII., p. 27, 1884.

Height of corallum figured (young example), 9 mm.; diameters of its calice, 7 and 6 mm. respectively; diameters of calice figured (aged example), longest 10·5 mm., shortest 9 mm. In the corallum of the latter the base is broken off, but the remaining portion is still 11 mm. high.

Locality.—Table Cape, Tasmania (Eocene). Fairly common, but usually worn. Collected by Professor Tate and J. Dennant.

This coral much resembles *P. supracostatus*, mihi. Its more exsert septa and difference in shape entitle it, I think, to specific rank.

GENUS STEPHANOTROCHUS, Moseley, 1881.

Corallum dense and compact in substance, cup-shaped or saucer-shaped, with trace of early attachment, usually with well-developed costæ, bearing a succession of small spines, with widely open capacious fossa. Septa usually extremely exsert, the exsert quinaries, or quaternaries, where these are not present, lying next to the primaries, higher than the tertiaries or equal to them. Columella absent or little prominent.

Four species of corals dredged by the Challenger Expedition, viz., three in the Atlantic and one off the coast of New South Wales, were at first referred by Professor Moseley to the genus *Ceratotrochus*. In his later special Monograph, however, he instituted the above genus for their reception. I have now to draw attention to a fossil coral from the Australian Eocene, which exhibits the essential characteristics of Moseley's genus.

Stephanotrochus Tatei, spec. nov. Pl. iii., figs. 1 a, b, c.

The corallum is saucer-shaped, but so shallow as to be almost discoid. Adult examples are compact in substance and free, but younger ones, besides being much thinner, show a small, rounded, and slightly depressed scar of former attachment.

The base is flat and roughly hexagonal in outline. The hexagonal angles are opposite the primary costæ, from each of which a long, stout, but gradually tapering spine projects obliquely downward (approximate angle with base, 145°), so that the coral when placed upon a flat surface rests on the points of six equidistant spiny processes. The basal edges bend gently round to form the wall of the corallum at an angle which varies in different individuals from 45° to about 60°. The costæ, which are continuations of the septa, are prominent on the sides of the corallum, and covered with transverse rows of granules, which give them a serrated appearance. On the base they are either obsolete or just traceable as slightly raised lines, the primaries and secondaries being more persistent than the rest. (It should be noted that the parallel bars shown in the centre of the base figured have no significance, and are absent in similarly worn

specimens). In full grown individuals the base, costæ, and spines are covered by a dense epitheca; younger ones have the epitheca thin and delicate. The calice is large, open, and scarcely concave; like the base it is hexagonal in outline, each angle being marked by the strong projection of a primary, and its two adjacent quinary septa. From the latter, the wall curves inwards towards the secondaries, where there is another, but much smaller projection.

The septa are in six systems, with five cycles; all extend beyond the wall in varying degrees, the primaries the most. In plan they exhibit the same peculiarities as were noted by Moseley in the case of the recent *S. nobilis*. The diagram given by him in the Challenger Report of a complete system in the recent form can, in fact, be cited as almost exactly representing the septal scheme of the fossil one. Of the four quaternaries in each system, the two nearest the primaries, besides being slightly thicker than the others, bend towards and join the tertiaries at from half to two-thirds from the wall; each half system is, in fact, trisected by these two connected septa, so that the tertiaries are, according to the theoretical order of cyclical development, unsymmetrically placed. The quaternaries adjoining the secondaries are straight and free, and approximately equal to the quinaries. Only four of the latter are present in each system instead of eight, viz., between each pair of connected septa, and flanking the primaries; on either side of the free quaternaries they are absent. In the type calice, the bent quaternary and the quinary between it and the adjoining tertiary are wanting for half of one of the systems. The principal septa increase gradually in thickness according to order as they approach the wall, especially the primaries, which become very stout; beyond it they taper off rapidly. The higher orders are just slightly thickened at the wall. The primaries and the quinaries next them are very exsert at the margin of the calice, where, also, the latter are joined to the former by a prolongation of the wall. A similar union of the free quaternaries with the secondary septa is also noticeable.

The costal tubercles proceeding from the base are really lateral continuations of the exsert primaries, and mark as it were the framework on which the coral is built; together they give it a most characteristic appearance. For the most part the superior portions of the septa are broken off in the specimens, but from occasional intact ones still left, it is apparent that in life all of them rose as fan-shaped structures of varying height near the wall. The primaries, secondaries, tertiaries, and bent quaternaries are hollowed out, and deeply notched in their middle portions, and then rise again in one or more smaller elevations,

also fan-shaped, nearer the centre of the fossa. The more central of these elevations are subequal in height, and might, perhaps, in a choked calice be mistaken for pali. It is only necessary to examine a specimen free from adhering sediment to see that they are integral parts of the septa, and not pali. All the septa have granules on their sides, which, especially on the surface of the fans, are arranged in a radiating manner; their upper edges are rendered very irregular from the presence here and there of little knobs and excrescences.

The primary, secondary, and tertiary septa extend to the centre of the calice, but before reaching it, they are twisted, often fused together, and all connected by much tortuous calcareous matter, having raised papilli on its surface. The columella so formed is therefore parietal only, but it occupies a large space in the calice.

The type specimen, which is an exceptionally well-preserved one, measures 18 mm. across the primary septa, and 14.5 mm. where narrowest; diameter of base midway between the hexagonal angles, 13 mm.; thickness through the centre of coral, 3.5 mm. A spine with point broken off is 5 mm. long.

The dimensions of a larger but worn specimen are:—Diameter of calice, 24 and 21 mm.; and of base, 15 mm.; length of spine, also broken, 8 mm.

Locality.—Tolerably abundant in the Eocene cliffs at Spring Creek, 13 miles south of Geelong, Victoria.

This elegant coral is quite unlike any other in the Australian tertiaries, but is closely allied to one from New Zealand, which was doubtfully identified by Ten.-Woods with *Trochocyathus* (?) *Mantelli*, Milne-Edwards. The latter has also basal tubercles, while the quinaries which respectively flank the stout primary and secondary septa are fused to them at the wall. A drawing of its base only was published by Mantell in 1850, and the above tentative name was added by Milne-Edwards. Woods' species is probably the same, but in the fragment described and figured by him pali were supposed to be present. An example, however, from the Waitaki River, in the Museum of the University of Adelaide, which has been placed in my hands, shows no pali, but only raised structures on the upper central margin of the septa just as in *S. Tatei*, and I therefore conclude that it should also be referred to Moseley's genus *Stephanotrochus*.

FAMILY EUPSAMMIDÆ.

Before describing the next species, a few preliminary remarks upon the characteristics of the genus *Trematotrochus*, in which I place it, are necessary.

In the original diagnosis of this genus by Ten.-Woods,* pali were supposed to be present, but the structures observed are merely the lobed or thickened ends of some of the principal septa. By Duncan they are called paliform lobes or dentations around the axial space. An amendment of the genus proposed by the latter author† was based upon Woods' drawings and description of *T. fenestratus*, the only species then known. To him is due the recognition of a third cycle of rudimentary septa answering to the third cycle of well developed costæ, but in some other respects his description is incorrect and misleading. The perforated wall, which is questioned by him, is, nevertheless, undoubted, and forms an essential characteristic of the genus. In regard to this I entirely concur with Woods, who remarks—“The pores go right through the wall; in fact, as the pores are very large, the portion of the wall which separates them becomes little more than a flat transverse bar.” I may add as confirmatory of his conclusion, that a longitudinal section of the coral, prepared so as to leave a portion of the wall intact, admits light freely through the pores. Duncan follows Woods in stating that there is no columella. As further detail, he adds—“The septa, which are large and equal, extend close to the axial space, and form a tube-like space.” The equality of the septa is evident enough from Woods drawings, his assertion to the contrary in the accompanying description being a mistake. The tube-like space is, however, not vacant, as might perhaps be inferred, but filled with hard nodular tissue, which, uniting with the septal ends, forms a columella. This is visible also in transverse sections of the corallum, cut either near the upper surface or close to the base. As to which of the two principal orders of septa should be considered the primary is not easily decided. I am inclined to reverse the order of development assigned to them by both the authorities quoted. In the new species described below, the lobed septa are, I judge, those of the second order.

Notwithstanding its perforated wall, the genus was placed by its author among the Turbinolidae on account of its supposed analogies with certain genera in that family. The second species referred to shows, however, in addition to a distinctly perforated wall, a regular fusing together of certain septa in each system at some distance from the margin, as in the genera of the Eupsammidae. I can, in fact, see no reason for the retention of the genus in the Aporosa Section of the Madreporaria, and place it instead under the Perforata. The regular perforations in the

* Proc. Royal Soc., New South Wales, vol. XII., 1878, p. 59, fig. 2.

† Revision of Madreporaria. Jour. Linn. Soc., Zoology, vol. XVIII., pp. 20, 21.

wall of *Trematotrochus* are well-represented by the radial pores on the base of *Stephanophyllia*.

In the following revised diagnosis of the genus I have noted what appear to be its essential attributes.

GENUS TREMATOTROCHUS, *T. Woods (emend)*.

Corallum simple, conical, free. Calice circular or elliptical with distinct margin. Costæ prominent. Septa in six systems, solid, and continuous with costæ. The inner ends of some are lobed and united to hard nodular tissue, which occupies the axial space and constitutes the columella. The highest cycle of septa is small or even rudimentary and corresponds to well developed costæ. Wall incomplete in the intercostal spaces, which are regularly fenestrated. Neither endotheca nor synapticalæ present. No epitheca.

Trematotrochus Clarkii *spec. nov.* Pl. iii, figs. 2 a, b.

The corallum is small and roundly conical in shape. It is slightly contracted at the calice, which is circular, with a sub-plane surface.

The septa are in six systems with four cycles. The primaries are free and of nearly the same thickness throughout. I select these as primary because they are continued on the wall by costæ which evidently constitute the original framework of the coral. Usually there is but one tertiary developed in each system and this joins the secondary at from one-third to a half from the wall. A single one of my specimens shows two tertiaries in four of the systems, the additional one present also joining the neighbouring secondary. Before uniting, the tertiaries and secondaries equal the primaries in thickness, but their fused portions are much stouter. In most examples, as in the one figured, there are thus 18 equal septa at the margin of the calice, but in the exceptional one mentioned there are 22. In all cases, however, the inter-spaces are approximately equal. Each of these is at the circumference medially divided by a cycle of rudimentary septa just as in *T. fenestratus*. These are very small, and, in fact, only occasionally visible in the calice as extremely short needle-like spikes. The septa of the three first orders are solid, exsert, and minutely granular on their sides; the secondaries are much lobed and indented in their thickened portions.

The columella is formed by hard nodular tissue, which occupies a small but well marked area between the opposite ends of the principal septa at the centre of the calice. The secondaries, and the primaries also in well preserved examples, unite with it, the thickened and lobed ends of the former rising slightly above its upper surface. It is continuous downward nearly, if not quite,

to the base of the corallum. In a young example lately collected, about two-thirds of the upper portion of the fossil has been worn away by fossilization, and at the bottom there is still a prominent columella.

The costæ are continuous with the septa, and thus vary in number exactly as these do. Including the quaternaries the total number of costæ is normally 36, but in the example mentioned with four extra tertiary septa, 44 separate costæ were counted at the upper margin of the wall, there being a quaternary in every interspace of the other cycles. The primaries are distinct and free right to the base; the tertiaries unite with the secondaries at varying heights on the wall from about two-thirds below the summit to quite close to the base. These three orders of costæ are stout and subequal in size, the primaries becoming, perhaps, slightly the stouter towards the base. The costæ of the fourth order are always well developed, and about half as thick as the others; they meet either the secondaries or the tertiaries at heights on the wall which vary considerably in the several systems. The intercostal spaces, which towards the upper margin of the corallum equal the costæ, are crossed by thin transverse bars, between which there is a series of regular pores similar to those in *T. fenestratus*; they are, of course, most conspicuous in the upper part of the corallum, where the intercostal spaces are widest. In the young example referred to above with worn and excavated calice, the pores are visible on the inner as well as the outer surface of the wall. Towards the margin of the calice also in most examples the complete perforation of the wall is plainly seen.

Altitude, 5 mm.; greatest diameter of corallum, 4 mm.; diameter of calice, 3 mm.

Locality.—Tolerably abundant in Miocene beds at Mississippi Creek, Gippsland Lakes area. Twelve examples. The species name is in compliment to Mr. Donald Clark, from whom I received my first specimen.

EXPLANATION OF PLATES.

PLATE II.

Fig.

1. *Flabellum Gippslandicum*—*a*, corallum, nat. size; *b*, calice, 3 diam.
2. *Flabellum fastigiatum*—*a*, corallum, nat. size; *b*, calice, 2 diam.
3. *Placotrochus corniculatus*—*a*, corallum, 1.5 diam.; *b*, calice, 4 diam.
4. *Paracyathus Tasmanicus*—*a*, corallum, 2.5 diam.; *b*, calice, 5 diam.

PLATE III.

1. *Stephanotrochus Tatei*—*a*, corallum, 2 diam.; *b*, base, 2 diam.; *c*, calice, 3 diam.
2. *Trematotrochus Clarkii*—*a*, corallum, 6 diam.; *b*, calice, 10 diam.
3. *Flabellum curtum*—*a*, corallum, 2 diam.; *b*, calice, 3 diam., showing three systems.